



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

OFFICE OF  
PREVENTION, PESTICIDES AND  
TOXIC SUBSTANCES

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MEMORANDUM

SUBJECT: Review of Metam Sodium Incident Reports  
DP Barcode D293158, Chemical #039003

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BACKGROUND

The following data bases have been consulted for the poisoning incident data on the active ingredient Metam Sodium (PC Code: 039003):

1) OPP Incident Data System (IDS) - reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) Poison Control Centers - as the result of a data purchase by EPA, OPP received Poison Control Center data covering the years 1993 through 1998 for all pesticides. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 65-70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs, household products, pesticides, etc.

3) California Department of Pesticide Regulation - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) National Institute of Occupational Safety and Health (NIOSH) SENSOR program - SENSOR is the Sentinel Event Notifications System for Occupational Risks and is a cooperative effort between NIOSH and about 10 state health departments which collect standardized data on pesticide incidents. Each case is classified by severity and certainty according to an agreed upon definition that makes data from different states comparable. Under special arrangement with NIOSH, Washington State prepared a report of cases reported since 1994 for this review

5) National Pesticide Telecommunications Network (NPTN) - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories human incidents, animal incidents, calls for information, and others.

## METAM SODIUM REVIEW

### I. Incident Data System

Incident#370-1 and Incident#6603-1 NM

A pesticide incident occurred in 1992, when utility workers accidentally pumped metam sodium into a home instead of into the main sewer. A remediation effort was initiated. As a result of exposure, a female resident reported permanent pulmonary injury and her husband had a headache and nausea 30 minutes after the exposure. No further information on the disposition of the case was reported.

**Incident#581-1 CA**

A pesticide incident occurred in 1991, when an employee injected metam sodium with a shank for about three and a half hours. The employee reported dizziness. No further information on the disposition of the case was reported.

**Incident#581-2 CA**

A pesticide incident occurred in 1991, when four employees conducted experiments with the product. Some of the degradation material escaped from the exhaust hood. The employees reported irritation. No further information on the disposition of the case was reported.

**Incident#581-3 CA**

A pesticide incident occurred in 1991, when an employee drove through a neighborhood and detected a strong odor. About thirty homes were later evacuated by a police department. The employee reported nausea. No further information on the disposition of the case was reported.

**Incident#581-5 CA**

A pesticide incident occurred in 1992, when one hundred gallons per acre of metam sodium was applied about twenty-five feet from a home. The spray drifted toward a nearby home. Three adults and three children (ages two, eight, and eleven) reported eye and throat irritation, dizziness, and nausea and were treated at a health care facility. No further information on the disposition of the case was reported.

**Incident#581-6 CA**

A pesticide incident occurred in 1992, when metam sodium was applied with a sprinkler system on the ground. About one hundred yards away occupants at a farm labor camp reported tearing eyes and headaches. No further information on the disposition of the case was reported.

**Incident#581-7 CA**

A pesticide incident occurred in 1992, when metam sodium was applied with a sprinkler system on the ground of a field. The product drifted nearby where residents reported upset stomachs, headaches, and burning eyes and throats. No further information on the disposition of the case was reported.

**Incident#581-8 CA**

A pesticide incident occurred in 1992, when metam sodium was applied with a sprinkler system about one half of a mile from a home. The product drifted nearby and a resident reported eye irritation. No further information on the disposition of the case was reported.

**Incident#581-9 CA**

A pesticide incident occurred in 1992, when metam sodium was applied with a shank injection system to a field about one hundred yards from a home. A resident reported burning eyes. No further information on the disposition of the case was reported.

**Incident#581-10 CA**

A pesticide incident occurred in 1992, when metam sodium was applied with a sprinkler system to a field about a quarter of a mile from a home. A resident reported eye and throat irritation. No further information on the disposition of the case was reported.

**Incident#581-11 CA**

A pesticide incident occurred in 1992, when metam sodium was applied with a sprinkler system to a field about a quarter of a mile from a home. Several residents reported a sore throat, eye irritation, and skin rashes. Seven residents were treated by a physician. No further information on the disposition of the case was reported.

**Incident#581-12 CA**

A pesticide incident occurred in 1992, when metam sodium was applied to the ground about a half of a mile from a fire station. The soil was sealed after the ground was tilled to four inches. After walking outside the fire station, a fireman reported burning and watery eyes and tightness in the throat. No further information on the disposition of the case was reported.

**Incident#581-13 CA**

A pesticide incident occurred in 1993, when metam sodium was applied with a sprinkler system to a ten-acre field. Nearby, eleven residents reported headache, nausea, and difficulty breathing. Six of the residents were treated by a physician. Faulty equipment and failure to properly follow the directions on the label resulted in this incident. No further information on the disposition of the case was reported.

**Incident#1168-1 HI**

A pesticide incident occurred in 1994, when metam sodium was applied as a preplant treatment to control nutgrass. Nearby, neighbors were evacuated. Specific symptoms were not mentioned. No further information on the disposition of the case was reported.

**Incident#2150-1**

A pesticide incident occurred in 1995, when a man, who is a tractor driver, reported skin rashes on the front and lower part of both of his legs, feet, and hands. The product is kept in storage tanks on the tractor. The man was treated by a physician who diagnosed him with a rash that was chemically induced. No further information on the disposition of the case was reported.

**Incident#2418-1 CA**

A pesticide incident occurred in 1995, when metam sodium was applied with a sprinkler system. Nearby, residents reported eye, nose, and throat irritation. No further information on the disposition of the case was reported.

**Incident#2695-3 CA**

A pesticide incident occurred in 1995, when metam sodium was applied with a sprinkler system to an industrial area. An inversion layer moved in and trapped the vapors. After reporting to work, eleven employees, who clean hazardous materials tanks, reported burning

eyes, and some had nausea, vomiting, and sore throats. No further information on the disposition of the case was reported.

#### Incident#2836-1 CA

A pesticide incident occurred in 1995, when metam sodium was applied with a sprinkler system to a field. The application site was sealed but nearby several inmates and staff reported watery eyes, nose and throat irritation, nausea, and vomiting. All of the individuals were treated by a physician. No further information on the disposition of the case was reported.

#### Incident#4410-1 and Incident#4627-1 CA

A pesticide incident occurred in 1996, when seven hundred and ten gallons of metam sodium was applied to a field by a shank injection followed by a ring roller for soil sealing. There may have been problems with the soil sealing. The field was about six hundred and sixty feet from a bus stop. The following morning, about 34 children reported watery eyes and were treated by a physician. No further information on the disposition of the case was reported.

#### Incident#4869-6 CA

A pesticide incident occurred in 1995, when six employees reported burning and watery eyes and nose, nausea, and sore throat after metam sodium was applied to a field about 3/4 of a mile away. The workers were then treated by a physician. No further information on the disposition of the case was reported.

#### Incident#4881-1

A pesticide incident occurred in 1997, when metam sodium was used to treat soil in a greenhouse. Several days later, two or three women entered the greenhouse and reported eye irritation about thirty minutes later. No further information on the disposition of the case was reported.

#### Incident#5722-1 CA

A pesticide incident occurred in 1997, when a field crew spilled the product and cleaned it up by covering it with cat litter. Two of the crew workers reported nausea, vomiting, and eye and throat irritation and were treated by a physician. No further information on the disposition of the case was reported.

#### Incident#6885-1 CA

A pesticide incident occurred in 1998, when a worker spilled the product on his boots. The worker kept the boots on for six hours and reported second to third degree burns on their feet. The worker was treated by a physician. No further information on the disposition of the case was reported.

**Incident#7015-1 NC**

A pesticide incident occurred in 1998, when a worker spilled the product on his boot. The worker washed the boot off and put it back on without a sock. About twenty minutes later the worker reported skin irritation. No further information on the disposition of the case was reported.

**Incident#7341-1 AZ**

A pesticide incident occurred in 1998, when a worker at a golf course got the product on his wrist and watch. The worker reported skin irritation. Two weeks later, the worker wore the same watch and again reported skin irritation. No further information on the disposition of the case was reported.

**Incident#7587-81 WA**

A pesticide incident occurred in 1996, when a thirty-five year old male applicator reported shortness of breath, dizziness, headache, and coughing. The man was treated by a physician. No further information on the disposition of the case was reported.

**Incident#7587-83 WA**

A pesticide incident occurred in 1996, when a eighty-two year old man reported chemical burns on his feet after walking in an area of an orchard that was treated with metam sodium. No further information on the disposition of the case was reported.

**Incident#8046-2**

A pesticide incident occurred in 1998, when a man, who is a farmer and wore gloves, was working outside and got the product on his hands that had an open wound. The man was treated by a physician and was diagnosed with a severe allergic reaction (edema, erythema). No further information on the disposition of the case was reported.

**Incident#8264-1 LA**

A pesticide incident occurred in 1997, when a worker spilled the product on his boots several years ago. Several years after the exposure, the worker reported pain in his bones. No further information on the disposition of the case was reported.

**Incident#8511-1 MO**

A pesticide incident occurred in 1999, when a woman, who works in a laboratory where metam sodium is handled, reported bumps and lesions on her entire body area. The woman was treated by a physician. No further information on the disposition of the case was reported.

**Incident#8647-1 and Incident#9106-1 CA**

A pesticide incident occurred in 1999, when an elementary school (about one hundred and sixty students) was evacuated after about 3,750 gallons of metam sodium was applied about sixty feet away. Seventeen teachers and students reported headaches, watery eyes, burning noses, vomiting, and sore throats and were treated by a physician. School was shut down for three days. No further information on the disposition of the case was reported.

#### Incident#8746-2

A pesticide incident occurred in 1994, when an individual was hospitalized after being exposed to metam sodium. Specific symptoms were not mentioned. No further information on the disposition of the case was reported.

#### Incident#9321-1 AZ

A pesticide incident occurred in 1999, when thirty farmworkers, who were transplanting cabbage, were exposed after the product was applied on a farm about a mile away. Two of the workers passed out. No further information on the disposition of the case was reported.

#### Incident#9599-5 and Incident#11169-1 CA

A pesticide incident occurred in 1999, when 150 people were evacuated from their homes after metam sodium was applied with a sprinkler system on a 160 acre field. Forty-six people were treated by a physician after reporting nausea, vomiting, headaches, burning eyes, and shortness of breath. About 28 report ongoing medical problems. The California enforcement office settled on a \$150,000 settlement fine for violations that permitted drift onto the neighboring community. No further information on the disposition of the case was reported.

#### Incident#12418-1 WI

A pesticide incident occurred in 2001, when a man, who is a truck driver reported difficulty breathing after a hose leaked during loading operations at a facility. No further information on the disposition of the case was reported.

#### Incident#13158-7 CA

A pesticide incident occurred in 2002, when a seventy year old woman, who has emphysema, reported watery eyes and difficulty breathing and was treated by a physician. No further information on the disposition of the case was reported.

#### Incident#13175-1 CA

A pesticide incident occurred in 2002, when 137 employees reported tearing and burning eyes at a vineyard. The product was sprayed on a field about one hundred feet east of the vineyard. Another 100 workers reported burning eyes. One of the workers reported nausea and was treated by a physician. The applicator reportedly violated label directions by not sealing treated soil when strong odors occurred and not posting the field under fumigation. No further information on the disposition of the case was reported.

#### Incident#13309-6 CA

A pesticide incident occurred in 2002, when five employees reported burning and tearing eyes, runny nose, nausea, vomiting, and tingling skin. Four of the five employees were treated by a physician. The product was applied with a sprinkler for several hours on a ranch. No further information on the disposition of the case was reported.

Note that the majority of incidents (24) listed above occurred in California and are also covered in section III. below. Ten incidents occurred in other states and four cases did not have

a specific state or country listed. At least half the incidents involved bystanders exposed due to drift. In several incidents, this drift occurred over a long distance of a quarter mile or more (see #581-8, 581-10, 581-11, 581-12, 4869-6, and 9321-1). In one report, 34 children were affected at a school bus stop several hours after an application that was 1/8 of a mile away (#4410-1).

## II. Poison Control Center Data - 1993 through 1998

Results for the years 1993 through 1998 are presented below for occupational cases, non-occupational involving adults and older children, and for children under age six. Cases involving exposures to multiple products and cases with unrelated medical outcome are excluded. Tables 1-4 present the hazard information for metam sodium compared with all other pesticides on six measures: percent with symptoms, percent with moderate, major, or fatal outcome, percent with major or fatal outcome, percent of exposed cases seen in a health care facility, and percent hospitalized and percent seen in a critical care facility. Table 1 reports the number of cases on which the data derived in Tables 2-4 are based. Table 2 presents this information for occupational cases, Table 3 for non-occupational cases involving adults and older children (six years or older), and Table 4 for children under age six.

Table 1. Number of metam sodium exposures reported to the Toxic Exposure Surveillance System (AAPCC), number with determined outcome, number seen in a health care facility for occupational and non-occupational cases (adults and children six years and older) and for children under six years of age only, 1993-1998 .

Subgroup	Exposures	Outcome determined	Seen in Health Care Facility
Occupational: adults and older children	74	55	43
Non-occupational: adults and older children	154	78	60
Children under age six	17	6	1

Table 2. Comparison between metam sodium and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1998 for occupational cases only.

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Metam sodium	89.1%	30.9%	1.82%	58.1%	4.65%	2.32%
All Pesticides	86.0%	18.8%	0.621%	47.0%	6.08%	2.36%
Ratio	1.04	1.64	2.93	1.24	0.76	0.98

\* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.



Table 3. Comparison between metam sodium and all pesticides for percent cases with symptomatic outcome (SYM), moderate or more severe outcome (MOD), life-threatening or fatal outcome (LIFE-TH), seen in a health care facility (HCF), hospitalized (HOSP), or seen in an intensive care unit (ICU) reported to Poison Control Centers, 1993-1998 for non-occupational cases involving adults and older children.

Pesticide	SYM*	MOD*	LIFE-TH*	HCF*	HOSP*	ICU*
Metam sodium	47.4%	11.5%	1.282%	39.0%	0.0%	0.0%
All Pesticides	68.5%	10.5%	0.359%	16.5%	6.24%	2.67%
Ratio	0.69	1.10	3.57	2.36	0.0	0.0

\* Symptomatic cases based on those cases with a minor, moderate, major, or fatal medical outcome. Denominator for SYM, MOD, and LIFE-TH is the total cases where medical outcome was determined. Denominator for HCF is all exposures. Denominator for HOSP and ICU is all cases seen in a health care facility.

Insufficient numbers of children under age six were exposed to metam sodium and reported to Poison Control Centers to warrant analysis. None of the 17 children exposed were reported to have a minor, moderate, or major medical outcome known to be related to their exposure. Occupational exposures to metam sodium were more likely to result in serious medical outcome than other pesticides, but health care was about the same or less than for other pesticides. Non-occupational exposures were more likely to result in moderate or major medical outcome (based on 9 and 1 case, respectively), but did not require hospitalization or critical care.

Dermal symptoms were most commonly reported among Poison Control Center cases with skin irritation/pain accounting for 36 cases where the symptom was known or possibly related to exposure. Other prominent dermal symptoms included erythema (flushing of skin in 15 cases), superficial burns (12 cases), rash (11 cases), severe second or third degree burns (6 cases), and edema (6 cases). Other common symptoms included eye irritation (18 cases), headache (10 cases), nausea (8 cases), difficulty breathing (4 cases), and vomiting (3 cases).

### III. California Data - 1982 through 2001

Detailed descriptions of 902 cases submitted to the California Pesticide Illness Surveillance Program (1982-2001) were reviewed. In 889 of these cases, metam sodium was used alone or was judged to be responsible for the health effects. Only cases with a definite, probable or possible relationship were reviewed. Four hundred and thirty-five cases were a result of six railroad cars and a locomotive that derailed by the Sacramento River. If these cases were excluded, metam sodium still ranked in the top 40 as a cause of systemic poisoning in California based on data for 1982 through 1994. The tables below exclude the 435 cases that resulted from the railroad car spill. Table 1 presents the types of illnesses reported by year. Table 2 gives the total number of workers that took time off work as a result of their illness and

how many were hospitalized and for how long. Additional information about the train derailment is provided in the literature section below.

Table 1. Cases Due to Metam Sodium in California Reported by Type of Illness and Year, 1982-2001.

Year	Illness Type					
	Systemic <sup>a</sup>	Eye	Skin	Respiratory <sup>b</sup>	Combination <sup>c</sup>	Total
1982	3	1	3	-	-	7
1983	-	-	1	-	-	1
1984	-	-	3	-	-	3
1985	1	-	1	-	-	2
1986	-	1	2	-	-	3
1987	7	1	2	-	-	10
1988	6	6	6	-	4	22
1989	3	1	5	-	-	9
1990	8	-	11	-	1	20
1991	4	1	6	2	-	13
1992	8	4	4	-	2	18
1993	10	2	6	-	-	18
1994	3	1	6	-	-	10
1995	36	-	3	2	5	46
1996	16	23	5	1	7	52
1997	9	-	9	-	2	20
1998	1	-	1	-	1	3
1999	121	18	4	5	34	182
2000	4	1	2	-	3	10
2001	4	-	1	-	-	5
Total	244	60	81	10	59	454

<sup>a</sup> Category includes cases where skin, eye, or respiratory effects were also reported.

<sup>b</sup> Category not used until 1990. Prior respiratory cases classified as systemic.

<sup>c</sup> Category includes combined irritative effects to eye, skin, and respiratory system.

Table 2. Number of Persons Disabled (taking time off work) or Hospitalized for Indicated Number of Days After Metam Sodium Exposure in California, 1982-2001.

Time period	Number of Persons Disabled	Number of Persons Hospitalized
One day	12	-
Two days	4	1
3-5 days	16	-
6-10 days	7	-
more than 10 days	5	-
Unknown	138	-
Indefinite	-	-

Worker activities associated with exposure to metam sodium are provided in Table 3 below.

Table 3. Illnesses by Activity Categories for Metam Sodium Exposure in California, 1982-2001

Activity Category	Illness Category					
	Systemic <sup>a</sup>	Eye	Skin	Respiratory <sup>b</sup>	Combination <sup>c</sup>	Total
Applicator	20	3	40	-	1	64
Mixer/Loader	2	4	17	-	1	24
Field Worker	11	-	4	-	-	15
Routine Indoor	127	13	3	5	31	179
Routine Outdoor	36	28	-	-	10	74
Other	44	11	14	5	16	90
Unknown	4	1	3	-	-	8
Total	244	60	81	10	59	454

<sup>a</sup> Category includes cases where skin, eye, or respiratory effects were also reported.

<sup>b</sup> Category not used until 1990. Prior respiratory cases classified as systemic.

<sup>c</sup> Category includes combined irritative effects to eye, skin, and respiratory system.

According to the above activity categories, routine indoor was associated with more exposures than any other category. These illnesses included symptoms of watery and burning eyes, sore throat, rash, headache, nausea, diarrhea, shortness of breath, respiratory and eye irritation. Incidents involving two or more bystanders are summarized below:

1987: Seven residents exposed to strong odor from nearby application, no doctor consulted.

1988: Drift across street into town affected 15 residents, principally burning eyes, itching, and headaches.

1992: Family of six affected after field treated and sealed with a roller.

1992: Family of five exposed to sprinkler chemigation in field across from their house.

1993: Six residents across road from fumigated field affected.

1993: Five affected by fog that came off fumigated field.

1995: 14 employees in manufacturing company 1/8 mile away developed symptoms after detecting odor. An inversion layer reported confined the vapor over their building.

1995: 6 employees affected by sprinkler application over 3/4 of a mile away. This application was reportedly closely monitored and in compliance with regulations and the illnesses were considered definitely due to the metam sodium exposure.

1995: 19 people affected by sprinkler application about half a mile away.

1996: Family of 4 drank from well with faulty valve that tested positive for metam sodium.

1996: 11 workers affected by pre-plant application 0.8 miles away. "A shift in the light wind and probable inversion layer contributed."

1996: 34 students at bus stop affected by application previous evening 1/8 of a mile away.

1997: 5 grape harvesters affected while working across the road from the treated field.

1999: 5 family members affected by odor from field half mile away.

1999: 170 residents and workers affected and 100 evacuated after nearby sprinkler application. An inadequate water seal, change in wind direction and weather inversion contributed to this incident. See detailed report by California Department of Health Services (summarized below in literature review).

2000: 6 people developed symptoms upon smelling the odor from a nearby field.

The incidents listed above demonstrate that metam sodium has the potential to cause serious problems to persons not involved in the application even though they may be far away from the site of application. Changes in wind direction and weather inversions can readily contribute to significant illness. Metam sodium accounted for nine percent of the nearly 1,000 drift-related cases reported in California from 1994 through 1997. It accounted for 22% of the incidents involving clusters of 10 or more people during the same time period. Two of the 13 incidents (15%) that involved drift of one-quarter mile or more were due to metam sodium from 1994 through 1997.

#### IV. NIOSH SENSOR State reports

NIOSH compiled data submitted by about five states for the 1998 through 2002 time period. Four states had reports of metam sodium incidents. One of those states, California, has already been reported on above and will not be included here. Arizona reported on two incidents. The first, in 1999, involved 18 farmworkers tending cabbage who were exposed to drift from a sprinkler chemigation from a field one-third of a mile away. Three cases were exposed by inhalation and 15 were exposed by ocular and inhalation routes. The most common complaints were eye irritation and tearing, nausea, headache, coughing, throat irritation, and

difficulty breathing. Fifteen of the cases were considered possibly due to metam-sodium and 3 were considered probably due to their exposure. All of the cases were seen in an emergency room and 5 were considered to have a moderate medical outcome and 13 experience minor medical outcome. Another incident in 1999 involved a truck driver whose shoes, feet, pants, and legs were soaked with metam sodium. This case was considered a definite poisoning with moderate effects of blistering and swelling of feet.

In Oregon there were three incidents involving six people. The first incident in 1999 occurred when 3 people across the street from an application (about 150 feet away) were exposed to drift and saw a doctor for moderate symptoms that were considered possibly due to metam sodium exposure. In a second incident in 2001 a farm worker experienced direct exposure resulting in minor symptoms and treated by a doctor. A third incident involved two utility workers exposed to drift who were seen in an emergency room for moderate symptoms.

Washington State Department of Health produced a report for this review of cases investigated from 1994 through 2001 (Morrissey and Tibbetts 2003). A total of 11 incidents were reported involving 20 symptomatic people who were classified as definitely, probably or possibly related to metam sodium exposure. A brief synopsis of each incident and recommendations from the Washington State Department of Health follow:

In 1994 a licensed pesticide applicator monitored chemigation of seven potato circles (125 acres each) at least twice. During his shift over 7,000 gallons of metam sodium were applied by water irrigation. Within 24 hours he developed red, itchy rash and blisters on his hands despite wearing rubber gloves and having monthly safety meetings, and maintenance of all personal protective (PPE) equipment. He has developed this same rash in the 3 years prior, in each case, within 24 hours of chemigation. This case was classified as probable by the Washington State Health Department.

In 1994, a 23 year old unlicensed and untrained farm worker was digging holes for new apple trees. He volunteered to help the fumigator who was leaving for vacation, by fumigating the last eight holes with a tractor-mounted tank connected to a hose and handgun. A sudden change in pressure led to his face and clothing being sprayed with metam sodium. He wiped off what he could and continued to work without changing clothes. Initial symptoms were burning eyes and trouble breathing. Later he had headache, nausea, vomiting, conjunctivitis in one eye, and redness on the face and neck. Washington State Health Department classified this case as definitely related to metam sodium exposure and questioned whether the label should require PPE for workers (especially hole diggers) near an application which is common when this type of fumigation occurs.

In 1996, a farm worker was fumigating holes for apple trees while wearing the required PPE. His respirator was new but he had no respirator training and he was not fit-tested. He did not know if or when cartridges were changed. After 30 minutes he had burning sensation on his forehead and congestion. Later he had headache, heaviness in chest, dizziness, nausea, anxiety, and cough. He sought medical care and was classified as a probable case.

In 1996, a retired 82 year old man developed chemical burns to the feet after walking in wet grass of an orchard that had been treated four days prior with metam sodium. He was wearing shoes and socks which became soaked after his walk around the orchard. He had pain, redness, swelling and blisters on his feet. Medical history made him more susceptible to dermal problems and edema. This case was classified as possibly related to metam sodium exposure.

In 1997 an applicator became sick while applying metam sodium to 539 acres of potato fields. He was conducting a chisel-plow subsurface application from a tractor and did not believe he needed to wear PPE inside the tractor cab. The tractor cab was found to be equipped with a simple air filter and was not an approved enclosed cab which would require a charcoal filter. He also performed the task of loading his tractor tank from a nurse truck. His symptoms began on the second day and included itchy skin, burning eyes, and by the fourth day, nausea, vomiting, abdominal cramping, and diarrhea. He sought medical care and was classified as a possible case.

In 1997 an unlicensed male farm worker applied metam sodium to apple tree roots while under the supervision of a licensed applicator. The application equipment was new and he was wearing required PPE. The hose disconnected resulting in metam sodium hitting him in the face. Despite goggles, metam sodium ran down into his eyes. He shut down the equipment immediately and rinsed his eyes with emergency water on the truck within one minute. He then ran 100 feet to a water faucet and washed his face and was driven to a hospital when symptoms of eye pain, blurry vision, and burning on forehead persisted. This case was classified as definitely related to metam sodium exposure.

In 1998 a farm worker experienced chemical burns to both feet after his leather boots became contaminated. He was performing maintenance when metam sodium splashed onto his boots at a manufacturing plant for metam sodium. He was wearing PPE except for his leather boots. His feet were red, itchy, and he later developed burning sensations and blistering at the end of his work day in this definite case.

In 1999, a farm worker was spraying dirt to prepare for planting apple trees. A small amount of metam sodium splashed into his eyes and he developed eye pain and irritation. Five days later he still had mild redness and itchiness of the eyes and somewhat blurry vision and mild pain. This case could not be classified because the worker could not be located for interview, though Washington State Health Department considers it a plausible or suspicious case.

In 2000, a worker was spraying with a handgun to kill worms in hops. He was not wearing PPE and had on leather boots. He accidentally sprayed the boots and continued wearing them without decontamination. Two to three days later he developed rash, redness, and raised bumps on his feet which lasted four days. This case was classified as probably due to metam sodium exposure.

In 2000, a number of employees (at least nine) complained of headache, burning eyes, sore throat, and nausea after a strong smell was noticed in their building. The building was in a low lying area next to agricultural crops that received chemigation the night before. A temperature inversion had held the volatilizing products near the ground where they could enter the building's ventilation system. Seventeen employees were sent home and eight were classified as probable and one possible from exposure to metam sodium. An additional eight workers reported at least one health symptom but choose not to participate in the investigation. A number of violations were found associated with this particular application of metam sodium (not specified).

In 2001, a worker was monitoring chemigation of potato circles while wearing full PPE. However, when he returned to his truck he removed the PPE and was parked 100 feet from the potato circle. He developed burning sensation in lungs and throat, and chest tightness. He reported that the burning in his lungs persisted for 1.5 months and shortness of breath lasted for more than two months. He had no prior history of asthma or allergies. This case was classified as possible. Medical records for this case were incomplete.

In 2001, two police officers developed burning eyes, tearing, nose and throat irritation during a 30 minute traffic stop next to a chemigation of a potato circle. There was only a very small strip of buffer between the field and the roadside. Medical documentation for these cases could not be located resulting in these cases being classified as possibly due to metam sodium exposure.

In summarizing the cases above, the Washington State Health Department made the following statement:

Metam sodium is presently in the re-registration process at EPA. As part of this process, Washington state is submitting case reports of illness to alert regulators to the types of problems occurring with metam sodium products. Washington State has monitored acute pesticide-illnesses since 1990. Primary health care providers are required by law to report such illnesses to the WA Department of Health (WDOH). WDOH also receives reports from the Washington Poison Center, workers compensation industrial insurance claims, other state and local agencies, and individuals. Included here are the 11 incidents involving 20 symptomatic people which were classified as definitely, probably or possibly related to Metam sodium exposure. In addition, one Unknown case was included because it was a plausible case that we were unable to confirm. The narrative provided for each case is expanded from what we generally release as a case description in our annual report. We hope that the additional details will be pertinent to EPA's assessment of label language for metam-sodium products.

Concerns identified in the illness case reports:

1. Workers did not comply with PPE requirements. (especially leather boots)

2. Workers (and their supervisors) did not understand the hazards of the product. In several cases the worker did not change out of clothing or shoes that had become drenched with the product.
3. Label for chemigation may not be sufficiently protective of health of applicator. (Worker monitoring the chemigation was exposed despite full compliance with label)
4. Strong smelling volatiles from chemigation can drift to surrounding community and cause irritant symptoms, especially during temperature inversions.

We encourage EPA to take a careful look particularly at metam sodium rules involving application by chemigation. Temperature inversions are common at the times that chemigation of potato fields occur in our state. Temperature inversions hold the volatile components of the fumigant close to the ground. Because chemigation is a surface application, it may produce more volatiles than deeper soil incorporation with chisels. It is common for people in nearby communities to complain of eye irritation during the seasonal time of intensive fumigation. Several cases below illustrate the problem. We have not had the resources in Washington to conduct a wide scale community exposure assessment during the fall fumigation season. The research work done in California, documenting community exposure to MTIC, indicates that additional attention is warranted.

## V. National Pesticide Information Center

On the list of the top 200 chemicals for which NPIC received calls from 1984-1991 inclusively, metam sodium was ranked 74<sup>th</sup> with 50 incidents in humans reported and 0 in animals (mostly pets).

## VI. Scientific Literature

Alexeeff et al. (1994) reported on estimated reference exposure levels (RELs) for individuals who were exposed to metam sodium after it spilled into the Sacramento River. Physicians at two different hospitals and an on-site evaluation center evaluated and interviewed them about their symptoms. During the next two weeks after the spill, more than 240 individuals were treated at an emergency room. The first individual was treated about twelve hours after the spill. Twenty-seven individuals were treated the day after the spill. Twenty-five individuals were treated at emergency rooms at two other hospitals. More than 300 individuals were treated at an evaluation center and private physicians treated almost 200 individuals. Seven individuals were hospitalized. Two out of the seven individuals had pre-existing asthma and another suffered from chronic obstructive lung disease. Most of the individuals reported throat and eye irritation, dizziness, vomiting, shortness of breath, nausea, and headache during the first five days after exposure. Chest tightness, cough, abdominal pain, diarrhea, and skin rash were also reported by some of the individuals. Other individuals reported hyperventilation or anxiety-like symptoms, including rapid breathing, tremulousness, and paresthesia (tingling around the mouth and fingertips). Additional data was provided modeling dose response.



Bowler et al. (1994a) reported on a study of psychological, psychosocial, and physiological effects of exposed individuals about three or four months after the metam sodium spill. There were 350 exposed individuals and 114 non-exposed individuals randomly sampled from a similar but unexposed town. The exposed individuals had significantly higher blood pressure levels and less reduction of salivary cortisol levels. The exposed individuals reported more neurological, memory and concentration, anxiety, depression, sleep disorders, headaches, visual, olfactory, dermatological, gastrointestinal, and cardiac symptoms than the controls.

Bowler et al. (1994b) reported on in-depth psychological, psychosocial, and psychophysiological effects after the metam sodium spill. The matched pair designed study (90 pairs of exposed and non-exposed individuals) included exposed and non-exposed individuals that were matched on age, education, gender, race, and number of children. The exposed individuals reported higher levels of depression, anxiety, and somatic symptoms and more environmental worry and lower perceived social support. Bowler et al. (1994b) cite a study by industrial hygienists which estimated peak exposure to MITC (methylothiocyanate) at 140-1600 ppb.

Bowler et al. (1996) reported on the results of a symptom checklist that was given to participants of three matched-pair study groups (460 individuals). The checklist included items such as neurological dysfunction, physical illness (respiratory and dermatological), gastrointestinal symptoms, visual problems, sensory problems, and cognitive and mood dysfunction. Study group 1 (124 individuals) is a Hispanic group who worked in a microelectronics plant and had extensive past exposure (about 6 years) to multiple organic hydrocarbon solvents. Study group 2 (180 individuals) is primarily a White community environmentally exposed to metam sodium. Study group 3 (156 individuals) is an African-American group environmentally exposed to sulfuric acid. Each of the exposed groups was compared to a matched unexposed group. In the metam sodium study group, the exposed persons had higher relative risks than the non-exposed persons for all symptoms except fainting. The highest ratios (relative risk of 3.0 or higher) were for lightheadedness, loss of strength in legs and feet, confusion, tremors, personality changes, difficulty concentrating, difficulty driving, nausea, diarrhea, skin rash, tightness in chest, perspiring, and loss of smell. The authors concluded that all exposed persons from the three study groups had significantly higher rates of symptoms than their demographically matched unexposed persons, suggesting a psychosomatic component to the development of these symptoms.

Burgess et al. (2000) reported on the Washington State Department of Health who investigated and reviewed fumigant-related illnesses reported to them from 1992-1996. A total of 2,759 pesticide-related illnesses were investigated. After investigation, 1,192 of the cases were classified as definite, probable, or possible pesticide-related illnesses. Of the 39 cases related to fumigants, nine involved exposure to metam sodium. Two of the nine cases were classified as definite, six were probable, and one was possible. Skin and eye irritation (6 and 5 cases, respectively), respiratory symptoms (4 cases), nausea/vomiting (3 cases), and headache (3 cases) were the predominant symptoms.

Metam sodium was used to fumigate soil either in orchards (5 cases) or field crops (4 cases) (Burgess et al. 2000). Four out of the five cases in orchards involved dermal contact with liquid when the equipment failed or the fumigant splashed into holes dug for new trees. Three of the field crop cases involved inhalation of gas while monitoring a fumigation, checking irrigation lines, or reentering the field within one to three days. The other field crop case involved a mechanic who received a dermal exposure while fixing application equipment in the field. Five cases reported moderate medical outcomes and the other four were considered minor. Three of the five moderate cases reported dermal irritation and edema after direct contact with liquid metam sodium that dissipated within one to two weeks. A fourth case reported second-degree chemical burns and required immediate decontamination. The fifth moderate case involved a 60 year old man, who wore personal protective equipment and used metam sodium in an orchard to fumigate the soil. He used the product for thirty minutes twice within two weeks in April. After the first application, the man reported red hands. After the second application, he reported burning on his hands and blisters within six hours. The man was treated with topical corticosteroids at an emergency room for extensive dermatitis on his left hand and wrist and purplish discoloration and swelling on the dorsal part of his hand. The man used the same gloves for both applications. As a result, skin contact was made through leaks in the gloves. Metam sodium requires the use of waterproof (not chemical resistant) gloves. The authors concluded that metam sodium might be a hazard to workers during reentry.

Burgess et al. (2000) concluded that workers should be better educated and workplace safety regulations should be better enforced to prevent metam sodium exposures. In their view, a specific test for certification for use of fumigants should be considered in Washington. Inadequate training and inadequate personal protective equipment were often a factor in fumigant poisonings. Direct supervision of workers handling metam sodium and other fumigants may not be adequate to protect handlers because “the term ‘direct supervision’ can mean simply within phone contact for agricultural applicators. . . . Improved worker education and enforcement of workplace safety regulations would help decrease the frequency of fumigant-related illness.”

Cone et al. (1994) reported on adults that experienced persistent respiratory disorders, including irritant-induced asthma, who lived and worked near the spill that involved metam sodium, after the derailment of a tank car. The tank car was filled with metam sodium that spilled into the Sacramento River and released over 19,000 gallons of the chemical. As a result, a toxic aquatic plume traveled down the river, about 40 miles, for over three days. Most of the nearby residents slept with their windows open. A total of 197 patients were referred to an occupational/ environmental health clinic or to a private practitioner with occupational/environmental expertise for further evaluation. A total of 48 patients out of the 197 patients reported persistent respiratory health complaints after the spill. Data was collected from the medical records, history, physical examination, spirometry, and methacholine challenge testing and revealed 20 cases of persistent irritant-induced asthma and 10 cases of persistent exacerbation of asthma.

The 20 cases with new onset of asthma due to exposure to metam sodium included 17 meeting the criteria for RADS (reactive airway dysfunction syndrome) because onset of lower respiratory symptoms occurred within the first 24 hours of exposure and three cases whose onset occurred after more than 24 hours but in the first week (Cone et al. 1994). Duration of exposure ranged from 4 hours to as long as 166 hours in the first week after the spill. These 20 cases included 9 women and 11 men with an mean age of 38 years. Their respiratory symptoms have persisted from 3 to 14 months and only one subject's symptoms had resolved as of the last clinical contact, 11 months after the spill.

Ten patients with an average age of 44 years experienced persistent aggravation of their existing asthma (Cone et al. 1994). Three patients required increased use of medication and two required new medications. At last contact, 3-15 months after exposure, all 10 patients still had increased problems with asthma compared to baseline prior to exposure. The authors concluded that although peak exposure levels may have been the most important variable, total duration of exposure was also likely to be a factor in the development of health effects associated with the spill.

Cone et al. (1994) noted that the Bhopal, India chemical release of methylisocyanate (MIC), like the metam sodium release, had resulted in acute irritative effects followed by other long-term respiratory effects. These effects included increased cough and phlegm, difficulty breathing, and evidence of reduced lung function (Beckett 1998, Cullinan et al. 1996, Cullinan et al. 1997, Gupta et al. 1988, Rastogi et al. 1988, Vijayan and Sankaran 1996). These authors, however, did not find or measure whether asthma or RADS increased in incidence or were exacerbated by the Bhopal explosion. The California risk assessment (California EPA 1999) of the metam sodium spill noted that MIC is also a byproduct of metam sodium release accounting for 4% of the corresponding MITC levels released into the air. Therefore, it is possible that MIC may be a contributor to the long-term respiratory effects reported by Cone et al. (1994) after the California Sacramento River spill. Surveillance of occupational asthma in Michigan and New Jersey found that from 1988 through 1992, isocyanates were the most frequently reported asthma-causing agents accounting for 19.4% of the cases (Centers for Disease Control 1994).

Koehler and Van Ness (1993) reported on prehospital and emergency medical service response to a train derailment near the Cantara rail curve. During the first three days, one hospital treated 87 patients who reported nausea (51%), headache (44%), eye irritation (40%), throat irritation (40%), dizziness (23%), vomiting (22%), shortness of breath (21%), and a few complaints of chest tightness, abdominal pain, diarrhea, and/or cough. The same symptoms predominated among 40 exposed callers, (July 15-19) to the U.C. Davis Regional Poison Center. The main purpose of this paper was to evaluate medical response capability rather than to evaluate the effects of the spill.

Koo et al. (1995) reported on a retrospective study among 42 jail group workers (41 inmates and 3 crew leaders) who removed dead fish from the Sacramento River after the metam sodium spill. Of the 42 workers, 27 (64%) developed dermatitis on their feet, ankles, and/or legs. For comparison, 48 state and federal employees who also worked on clean-up in the river

were interviewed. None of these other clean-up workers reported dermatitis, likely because three-quarters of the 31 workers whose feet became wet immediately changed to dry clothing. The following information was gathered from all workers: any known history of exposure to agricultural, factory, or other chemicals, especially rubber, any prior history of skin rashes (atopic eczema, poison oak, hives, rubber or chemical allergy), the use of personal protective gear (rubber waders, gloves, or leather boots) during the clean-up, known contact of the upper and lower extremities with possible sources of irritants, the length of time in the river, the extent of bodily exposure to river water, and changing to dry clothes after becoming wet. The dermatitis developed about 0-18 days after the workers cleaned-up the river, peaking at 3-4 days after initial exposure. The most frequently reported symptoms included redness (96%), itching (81%), and scaling (78%), bumpiness (56%), pain (37%), burning (30%) and blistering (26%). The authors noted that workers in the river may have been exposed to MITC or to one or more methylamines that were likely produced by decomposition of the dead fish and other animals. Prolonged contact with water in semiocclusive boots was thought to be an important factor in causing this irritative dermatitis.

Kreutzer et al. (1996) provided a summary of the health effects reported due to the metam sodium spill in the Sacramento river in California in 1991. A total of 705 persons with symptoms were identified. Headache (64%), eye irritation (48%), nausea (46%), throat irritation (42%), dizziness (30%), and shortness of breath (27%) were the most common symptoms reported. The authors concluded that “the time course for symptom reports, large number of symptom reports, consistency of symptoms with known toxicologic endpoints, and compatibility of symptom reports with exposure predictions favor the interpretation that MITC caused the health problems” reported in the nearby community after the spill.

In a review of odor associated health complaints Shusterman (2001) reviewed the levels of irritation and odor perception related to the metam sodium spill in the Sacramento river. He noted that public health officials concluded that the odor reported by residents was “largely a sentinel phenomena related to the presence of hydrogen sulfide as one of the two main metam sodium breakdown products. The agent thought responsible for the majority of the mucous membrane/irritant health complaints, on the other hand, was MITC. Airborne concentrations of the latter compound were documented beginning the third day after the spill, at which time measurements ranged as high as 37 ppb. Exposure concentrations for earlier periods were back-extrapolated using water concentration data and were estimated to have peaked in the 14-1600 ppb range” (citing Alexeeff et al. 1994). He noted that MITC is one of small group of compounds with an irritation threshold that is lower than its odor threshold.

The California Environmental Protection Agency (1999) performed a human health assessment on MITC. Subjects were exposed to MITC in air and reported eye discomfort irritation during a four hour exposure to 0.8 ppm. Subjects recovered within 20 minutes of the time that exposure was discontinued.

California Department of Health Services (CDHS 2001) summarized an incident involving a sprinkler application of metam sodium and evacuation of an elementary school

nearby in 1999. Over a six day period two fields were fumigated in preparation for planting carrots. On day four of the application an odor complaint was made by an automotive repair shop about a mile away from the field being treated. On day six, complaints of odors and sick children were reported by the nearby elementary school. After paramedics set up medical screening on school premises, the Fire Dept. recommended evacuation of the school at 1:10 p.m. School remained closed the next day. Trace levels of MITC were detected in all eight air-monitoring samples at the elementary school about 36 hours after the final application of metam sodium. CDHS identified at least 3 workers who were poisoned by metam sodium among 10 workers interviewed. Primary symptoms included cough, throat irritation, nausea, headache, and eye irritation and tearing. A buffer zone of 500 feet separated the school from the nearby field. The CDHS review did not include non-occupational exposures or 27 potentially exposed workers who were not interviewed. This plus the lack of recognition of symptoms or their connection with the exposure by individuals or their health care providers meant that the extent of illness was likely underestimated.

CDHS noted that “The detection of odor and onset of symptoms in this incident most closely coincides with the applications to Field #2 on days four and six . . . Therefore, CDHS concludes that the application of metam-sodium to Field #2 probably caused the illnesses of the workers about one mile away in the vicinity of the automotive repair shop on Monday evening, and at the school on Wednesday morning.” Based on these findings and other illness reports the CDHS concluded “that the current buffer zone restrictions for metam sodium applied in the overhead sprinkler system are not adequate to prevent pesticide illness.” CDHS recommended a “minimum one-mile worker buffer zone should be required for all sprinkler applications of metam sodium” for at least 72 hours and noted that even this requirement might not be 100% effective.

## VII. Conclusions

Metam sodium poses a hazard to bystanders exposed to relatively low levels from off-site drift. The effects of drift are usually minor to moderate leading primarily to irritant effects to eyes, throat, and skin, headache, nausea, and shortness of breath. A serious threat to bystander health reported by Cone et al. (1994) is the development and the exacerbation of asthma in 20 and 10 adults exposed to the fumes from the Sacramento river spill in California. The potential for metam sodium to drift and cause health effects at distances above one-quarter mile and many hours after application is well documented. Direct contact of metam sodium to skin surfaces is well documented to cause irritative dermatitis. The potential for health effects to large numbers of persons in communities and schools adjacent to metam sodium applications, either by a sprinkler system or poorly sealed soil fumigation is also well documented.

## VIII. Recommendations

Metam sodium use should be restricted to applicators who are certified. Researchers and State authorities in Washington noted that “inadequate training and personal protective equipment” are a common theme in fumigant poisonings and recommended “improved worker education and enforcement of workplace safety regulations” (Burgess et al. 2000). The Health Effects Division (HED) concurs with this recommendation. There should be specific training and testing on fumigant use made part of the certification program for applicators (see recommendations for methyl bromide, Blondell and Spann 2002). Applicators should be required to be certified and not just under the direct supervision of someone who is certified. HED also concurs with the California recommendation that sprinkler applications of metam sodium should have a one-mile buffer zone and 72 hour time period after application before reentry into the affected area.

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